

CCS: a technology update

IENE Event
“Prospects for CO₂ Capture & Storage in Greece”

Louis Sonnnois

Kozani, December 17th 2009

POWER

ALSTOM

- Introduction to Alstom
- Update on Carbon Capture
- Importance of Capture ready
- Conclusions, Q&A

The Alstom Group

A worldwide leader in its activities



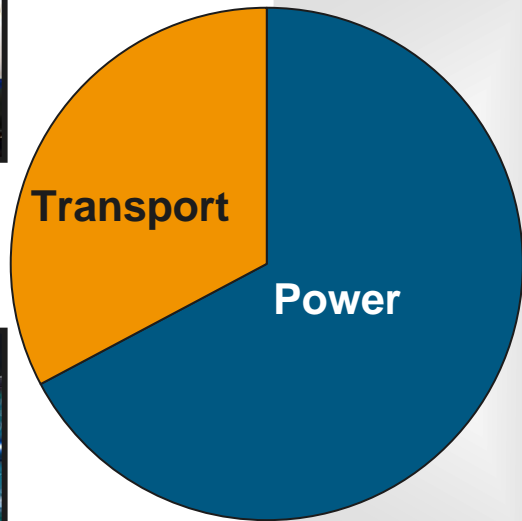
Total orders 2008/09:
€ 24.6 bn



N°1 in high speed and very high speed trains



N°1 in urban transport (metros and trams)



N°1 in hydro power



N°1 in integrated power plants



N°1 in conventional nuclear power island



Recent acquisition of wind power



N°1 in air quality control systems



N°1 in services for electric utilities

Alstom's answer to CO₂ challenges



Supply-side CO₂ emission reduction

- Technology Mix

- Nuclear
- Renewables



N° 1 hydro
Tidal



Wind and geothermal



N° 1 nuclear
(conventional islands)
& biomass

- Production Efficiency

- Fuel Preparation/Retrofit
- New generation plants
- Energy management



Efficiency: Plant
optimisation & retrofit

- Carbon Capture and Storage



First CO₂ capture demo
plant in the world

Alstom offers a portfolio of solutions

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Status of CCS development

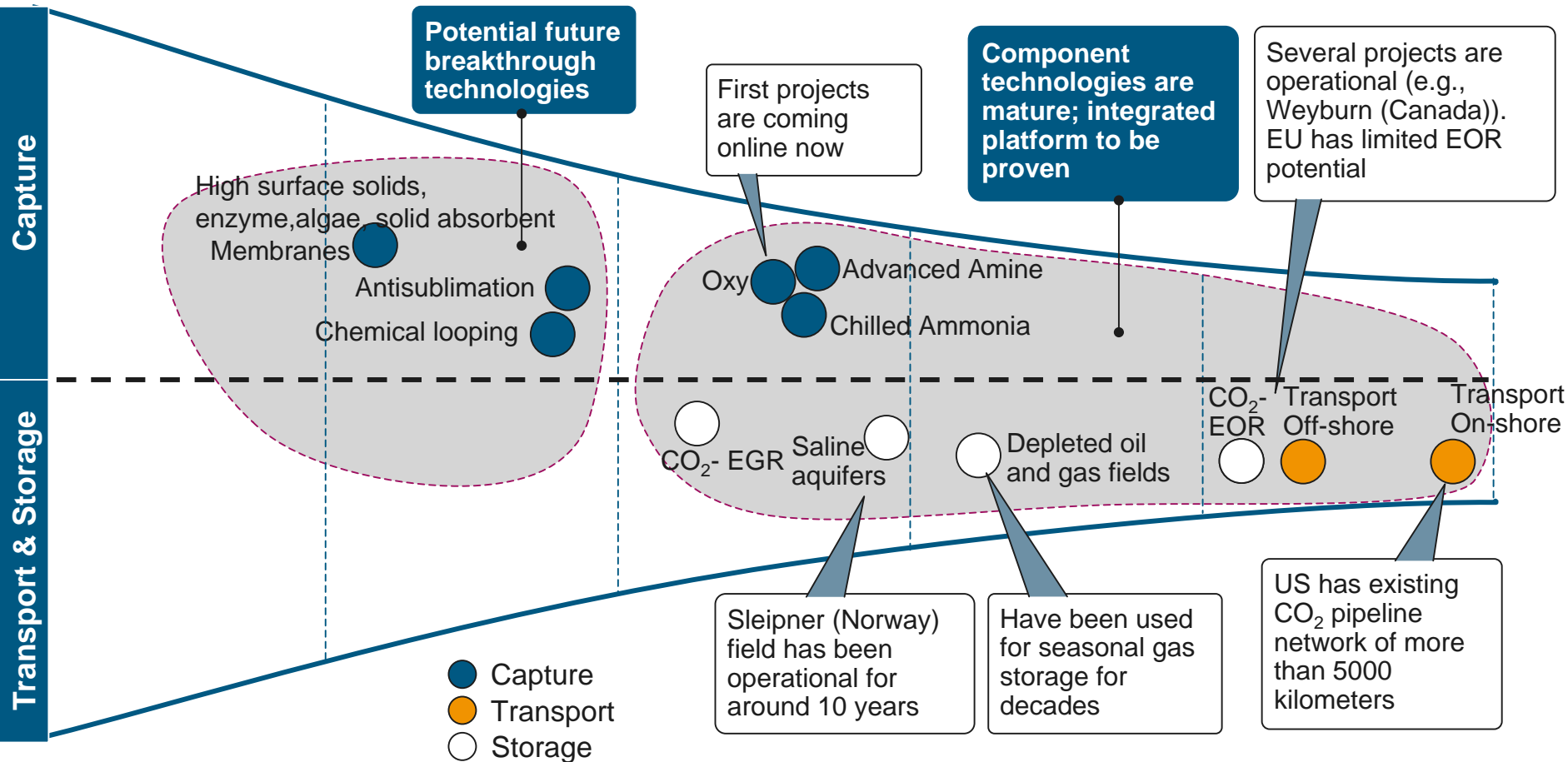
Concept

Lab testing

Demonstration

Commercial
refinements needed

Commercial



Source: Adapted from McKinsey

CO₂ Capture Solutions within Alstom

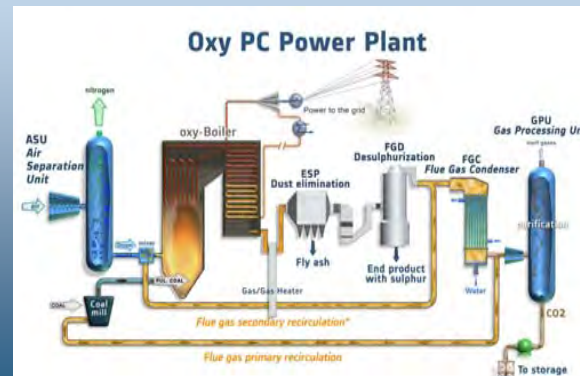


Power Plant with CO₂ capture

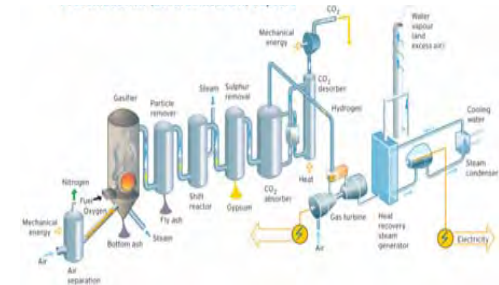
Post-combustion (New + retrofit)



Oxy-combustion (New + retrofit)



Pre-combustion (New only)



Source: Vattenfall

Solutions developed by Alstom

CCS must be also applied to the installed base

Main Partnerships & Projects Portfolio



Advanced Amines	Joint development programme West Virginia Pilot (USA) - Coal			ALSTOM
	Belchatow (Poland) – Lignite	>250 MWe		ALSTOM
	Archer Daniels Midland (USA) – Coal			ALSTOM
Chilled Ammonia	Pleasant Prairie (US) – Coal	5 MWt		ALSTOM
	Karlshamm (Sweden) – Oil/Gas	5 MWt		ALSTOM
	Mountaineer (US) – Coal	58 MWt		ALSTOM
	Mongstad (Norway) – Gas	40 MWt	Catching our Future	ALSTOM
	Mountaineer (US) – Coal	235 MWe		ALSTOM
	TransAlta (Canada) – Coal	200 MWe		ALSTOM
	Schwarze Pumpe (Germany) – Lignite	30 MWt		ALSTOM
Oxy-combustion	Lacq (France) – Gas	30 MWt		ALSTOM
	Alstom Boiler Simulation Facility Windsor (US) – Coals and Lignite	15 MWt		ALSTOM
	Jänschwalde (Germany) – Lignite	250 Mwe (Feasibility study)		ALSTOM

6 Pilots in commissioning/operation

Tests completed

Alstom activity on 12 major demonstrations



Operating



Vattenfall Schwarze Pumpe
Germany - 30 MWth
Oxy - Lignite



AEP Mountaineer
USA - 58 MWth
Chilled Ammonia - Coal



EoN Karlshamn
Sweden - 5 MWth
Chilled Ammonia - Fuel



Total Lacq
France - 30 MWth
Oxy - Gas



Dow Chemical Co.
USA, West Virginia
Advanced Amines - Coal



Alstom BSF Windsor
US - 15 MWth
Oxy - Coals

Coming



PGE Belchatow
Poland - 260 MWe
Adv. Amines - Lignite



Vattenfall Jämschwalde
Germany - 250 MWe
Oxy - Lignite



Statoil Mongstad
Norway - 40 MWth
Chilled Ammonia - Gas



Transalta
Canada - >200 MWe
Chilled Ammonia - Coal



Archer Daniels Midland
USA, Illinois
Advanced Amines - Coal



AEP Mountaineer
USA - 235 MWe
Chilled Ammonia - Coal



Selected for receiving EEPR funding



Selected by Alberta and Federal
Canadian funding



Selected by US DOE to receive CCPI
Round 3 funding



Belchatow Power Plant

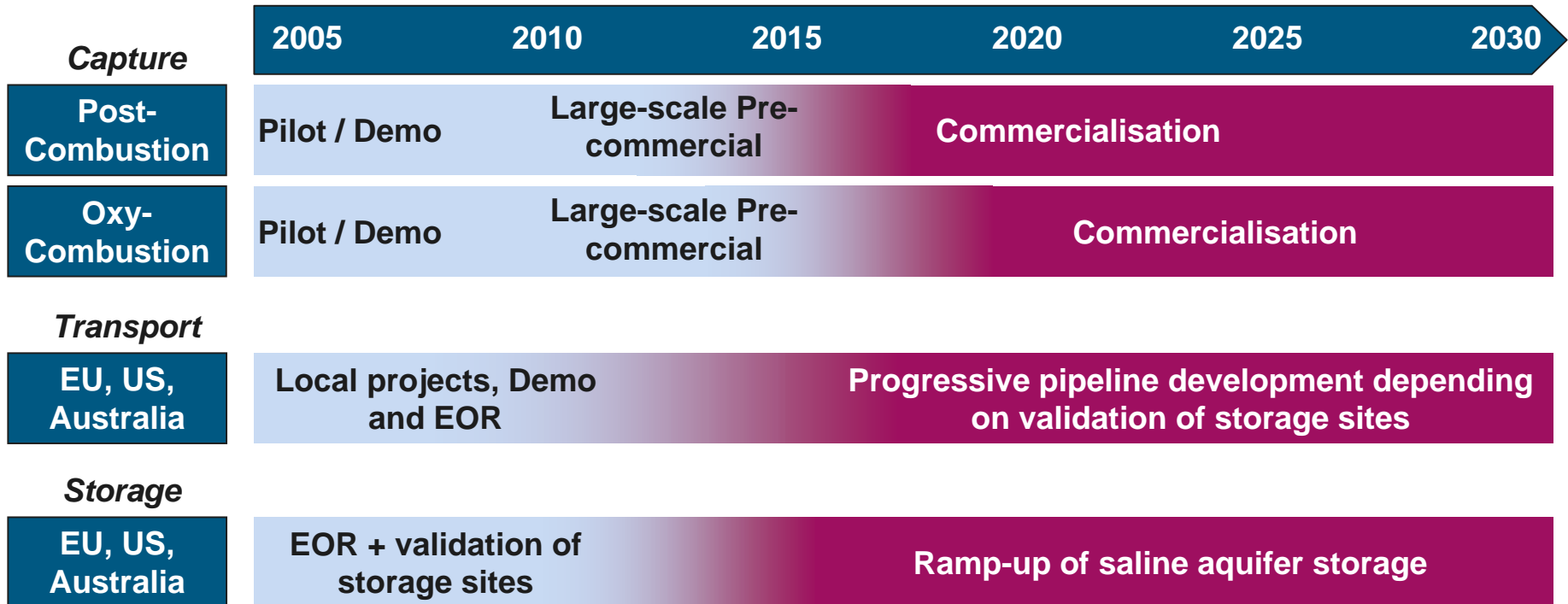


Technology Demonstration Program

- MOU between Alstom and PGE Elektrownia Belchatow, for a large CCS facility
 - Host facility 850 MW lignite unit under construction
 - Greater than 1.8 million tonnes CO₂ captured per year
 - Detailed engineering to start in January 2010
 - Operational in end 2014/early 2015

Selected for receiving EEPR funding

CCS: The Roadmap



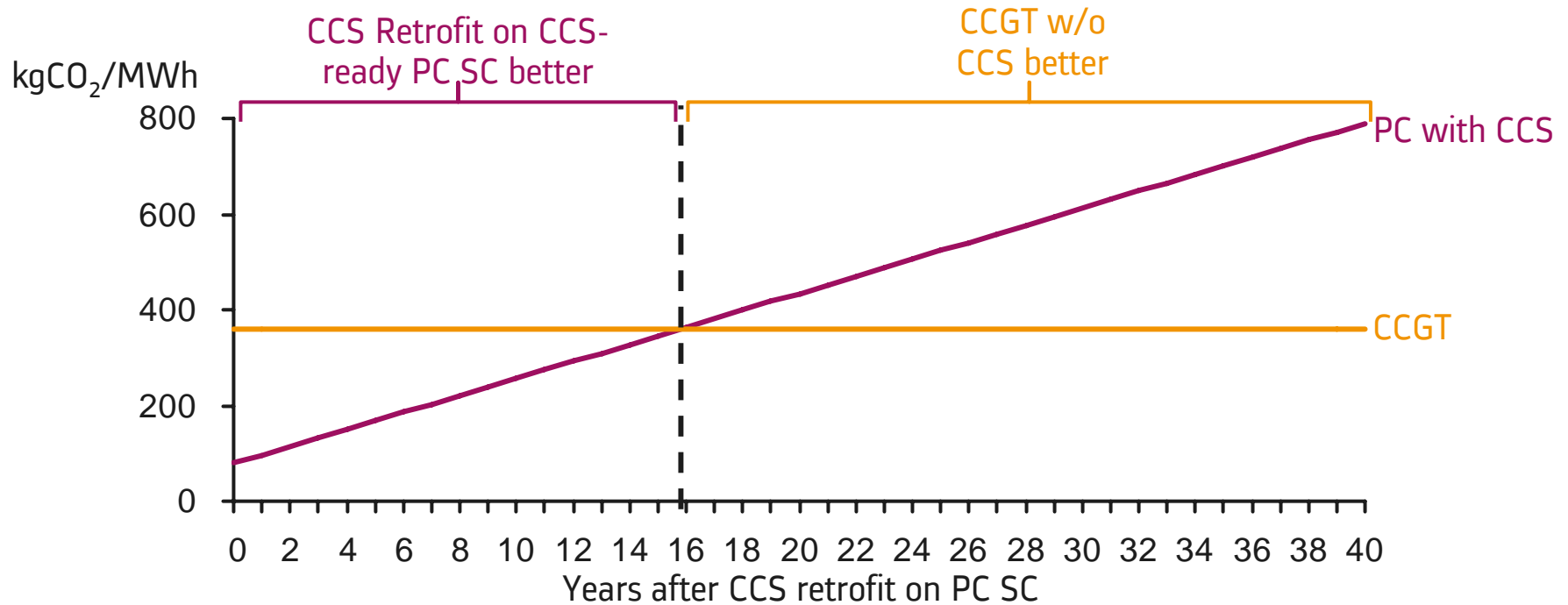
CCS will be fully commercial in 2015

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Illustration of a CCS retrofit of a USC PC



Average emission factor of a PC USC capture-ready retrofitted with 90% capture and a CCGT without capture



Note: Considering a 40 years lifetime for PC and similar operation mode before and after CCS retrofit

Source: Alstom Analysis

PC USC retrofitted with CCS before 16 years of operation has lower CO₂ emission factor on its total lifetime than a CCGT without CCS

European Union

- Scope: All combustion plants >300 Mwe (coal and gas)
- Requirements:
 - Assessment of availability of **suitable storage sites** and **technical and economical feasibility of CO₂ capture and transport**
 - **Suitable space** for future CO₂ capture system if conditions are met
- In addition, the UK has proposed to require, for **all new coal-fired** plants, to **demonstrate CCS** on at least 300MW of net capacity or 400MW of gross output and **to retrofit CCS to the whole plant** within 5 years of 2020

Europe is leading the CCS-ready way, let's do it!

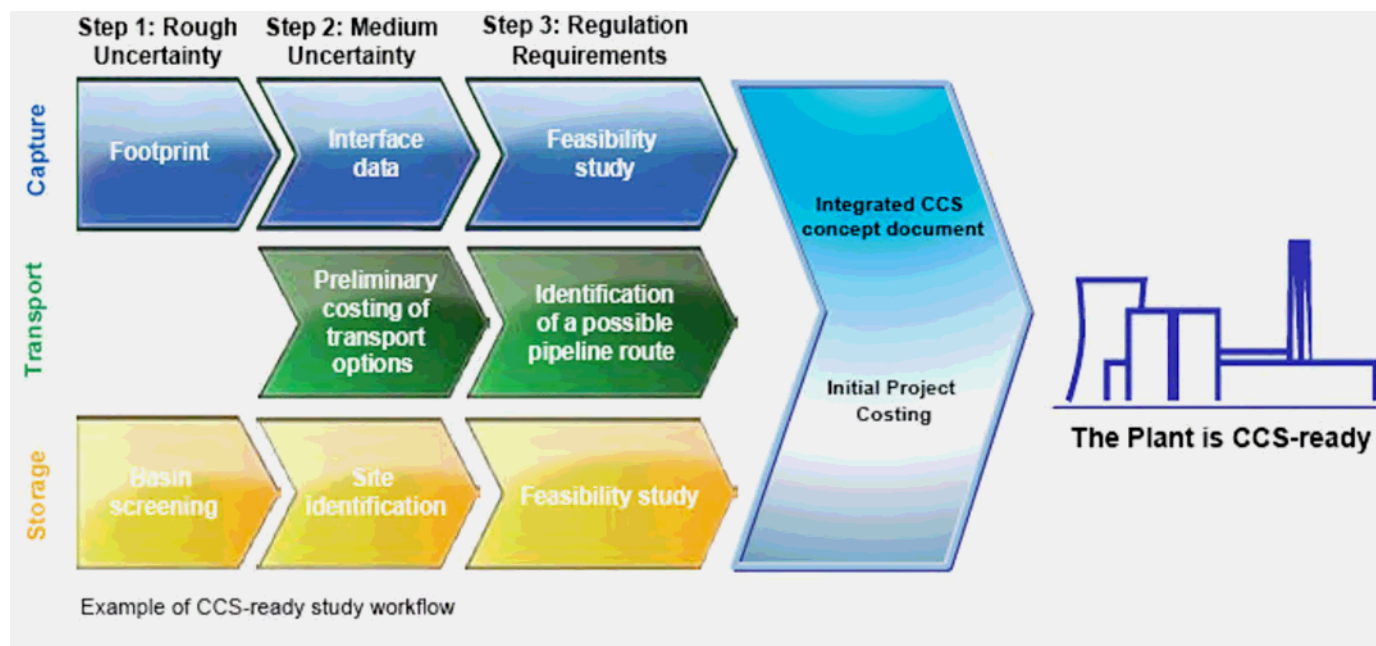
Addressing CCS Ready

CO₂ Transport and Storage Readiness Solutions



Alstom and Schlumberger combines their expertise to assess the CCS-readiness of power generation projects. Benefits are:

- Anticipate emerging requirements in the world, already Pre-requisite for permitting in EU
- Facilitate investment decisions and mitigate risk of carbon-stranded assets
- Optimize techno-economic options for future CCS conversion



Transport and storage also have to be addressed

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- Reducing CO₂ emissions from the Power sector is an absolute need
- A **portfolio approach** is needed: Renewables, Nuclear, Efficiency and CCS. Alstom provides all these solutions
- Retrofittable **CCS technologies** are a must to have
- **Large-scale demonstration** are key to demonstrate a competitive technology to capture CO₂ and **Alstom's partnerships and demonstration** projects are on the path for full-scale commercialisation of CO₂ capture technologies
- **CCS-Ready Power plants** are an absolute need, and demonstrate that the usage of local, cheap and abundant lignite resource can be compatible with the aim at **limiting sharply CO₂ emissions**

Alstom is fully committed to provide solutions for Clean Power production

www.power.alstom.com